The Relativistic Stern-Gerlach Interaction as a Tool for Attaining the Spin Separation

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We have exhaustively demonstrated [1],[2],[3] that the relativistic Stern-Gerlach interaction can play a decisive role in accomplishing the spin states separation of a high energy unpolarized beam of protons and, possibly, of antiprotons, since the relative energy kick is proportional to the Lorentz factor γ. Three rings, either operating (RHIC and HERA) or under development (LHC), are considered and, seen the very promising data resulting from the last one, our attention has been concentrated on the LHC. As regards to the separation of the states spinup and spin-down of the particles circulating in a ring, required for obtaining two new polarized bunches, some aspects are investigated in this contribution. They are the spin precession within the rf TE cavity, the spurious effects due to the transverse electric field and the harder problem of the .lamentation. In fact, during the synchrotron gymnastics the bunch rotates about the center of the longitudinal phase plane changing its shape from an elipse to a more and more exotic spiral. This will obviously mix the bunches containing particles with opposite polarization thus thwarting the effort of obtaining the separation of the two states in the same bucket. To overcome this drawback we propose to proceed in two directions. The first is to add more harmonics to the fundamental rf of the Stern-Gerlach cavity; the second consists in minimizing the phase-slip factor factor by raising the ring's transition energy. Moreover, we recommend a reduction of the design momentum spread, if possible even at the expense of the beam's intensity, and an increase of the peak magnetic field in the cavity from 0.1 tesla to 1 tesla which should be achievable.

References

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